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TAKEUPS for slurry elevators
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DRAGPEB metal lining for pulverizers
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ENGINEERS

225 Broadway **New York, N. Y.**

Designers and Equippers of Cement Making Factories

CEMENT MILL SECTION of

Concrete

The Cement Mill Edition of Concrete is edited exclusively for those interested in the manufacture of portland cement. Its pages are devoted to discussions of plant design, management, operation, production efficiency, chemical research and control, quarry operation, progress and news of the industry.

The Cement Mill Edition also contains all the material published in the corresponding Regular Edition and so provides news of the uses and merchandising of the materials whose manufacture is discussed in the Mill Edition. The Regular Section furnishes mill operating officials and mill executives valuable points of contact with the users of the materials they produce.

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Sintering Grate and Rotary Kiln Gain Fuel Economy

Ten European Plants Using System—Managements Prefer Fuel Economy to Heat Recovery—Dust Removed From Gases —Other Methods for Reducing Kiln Fuel Requirements

By T. H. ARNOLD
Consulting Engineer, Plainfield, N. J.

THERE is a characteristic difference in the methods and devices which have been developed in America and in Europe for increasing the efficiency in the utilization of fuel in the burning of cement clinker. Greater utilization of the best practice on both sides of the water would result in the most satisfactory commercial results.

The fuel cost remains today the greatest single item in the manufacturing cost and the one which offers the greatest opportunity for introducing savings of a worthwhile nature. Some progress has been made along this line, but the best results so far attained have fallen far short of what reasonably might be expected in modern practice.

Heat Required to Burn Barrel of Clinker

As a basis for discussion, the following figures will represent good results for regular operation in a modern plant with average supervision. We will assume for comparison that a coal is used which has a heat content of 12,500 B.t.u. per pound, and which costs $5.00 per ton delivered in the pulverized coal bins in the kiln department. The various authorities are not in exact agreement on the actual amount of heat theoretically required to burn a barrel of cement clinker. It is probable that this amount will vary somewhat with the materials used. Without quibbling over minor differences, however, we may assume that, for practical purposes, 412,000 B.t.u. will be required, theoretically, to heat the materials, drive off the CO_2 and to burn a barrel of cement clinker. This covers only the heat for the chemical processes, with no allowance for losses and no credit for heat reclaimed from the materials or gases. Thus 33.0 lb. of 12,500 B.t.u. coal is actually required in a perfect process, or at a cost of $5.00 per ton the fuel cost will be 8.25 cents per barrel.

Table 1 and the diagram in Figure 1 give the comparison with the theoretical.

Naturally it is impossible to consider all this loss as available for recovery; but undoubtedly this consumption can be greatly reduced. Much thought has been devoted to this matter and considerable progress has been made toward its reduction, both here and abroad.

The American manufacturers of cement have been expanding their production to meet the demands of a rapidly growing market. This condition has existed from the beginning of the industry in this country. Though at times there appeared a temporary over-production from the new plants being built, only a few years were required for new uses of concrete to consume the surplus. It would

". . . the new era which we are entering may give us a different technique in which less attention will be directed to maximum output and more to real economies in the process."

Achieving "real economies in the process" is the theme around which T. H. Arnold has written this article and about which he will write two more, to appear in future months.

The economies of kiln fuel and the working at cross purposes of kiln efficiency and waste heat recovery are examined in this chapter.

It was back in 1910 that Mr. Arnold first made the acquaintance of the cement industry. Carl Leonardt, late head of the Southwestern Portland Cement Company, was having difficulty in getting the electrified plant at the El Paso, Texas, plant to function. Arnold entered Mr. Leonardt's employ and subsequently helped to solve many of the problems which came up in the early application of electric drives to cement making machinery.

With the erection of the Southwestern plant at Osborn, Ohio, Mr. Arnold was transferred there in charge of construction of the power plant and the first all-push button complete starting equipment for a cement plant. It was while engaged in this work that he wrote, with R. R. Coghlan, the series of articles on "Power Plant and Kiln Design and Operation" which appeared in the issues of *Concrete* from October, 1926, to July, 1927.

One of Mr. Arnold's most recent charges has been the supervision of power and electrical matters in Russian cement plant construction, through which he gained invaluable knowledge of the best European methods in use.—The Editors.

appear that, along with the development of quantity production in other lines, the era of rapid development in manufacturing capacity has about reached its limit. While continued growth in the amount of cement used may be expected, the future rate of increase will not be so rapid as in the past.

TABLE 1

Heat Required Per Barrel of Clinker

Process	Fuel consumed per barrel Lb.of 12,500 B.t.u. per barrel	Fuel consumed per barrel Lb.of 12,500 B.t.u. coal per bbl.	Cost of fuel, in cents per barrel Total cost	Cost of fuel, in cents per barrel Cost of losses	Cost of fuel, in cents per barrel Per cent lost
Dry	1,125,000	90	22.5	14.25	63.3
Wet	1,250,000	100	25.0	16.75	67.0
Theoretical	412,000	33	8.25	----	----

High Output No Longer Paramount

This constantly increasing demand has insisted that American manufacturing technique be largely based upon producing the greatest possible output from each machine installed. High fuel consumption and machinery maintenance charges have been justified on the grounds of lower overhead from quantity production. Considerable thought has been devoted to attaining lower fuel consumption with these high output rates, but always high output has been the first consideration. It is possible that the new era which we are entering may give us a different technique in which less attention will be directed to maximum output and more to real economies in the process.

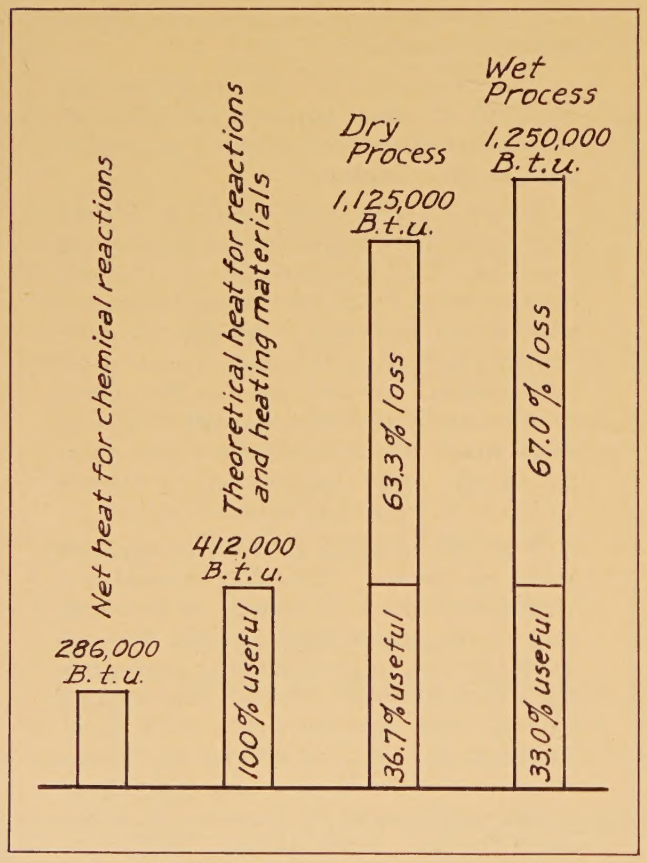


Figure 1. Utilization of heat in modern cement kilns

Kiln Efficiency vs. Heat Recovery

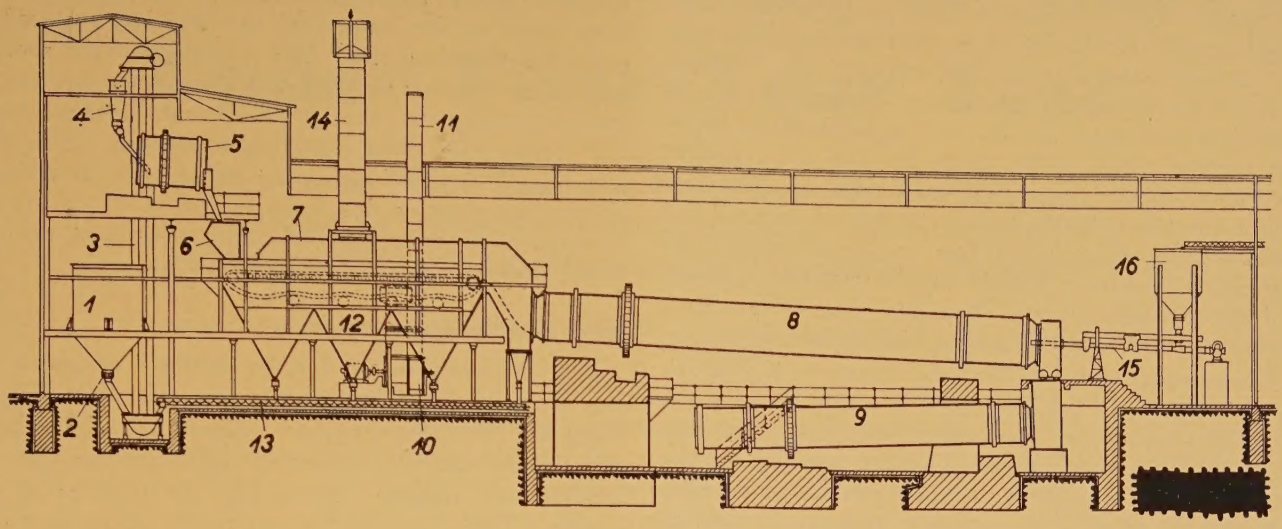
To absorb the excess heat which was required for the high production rates in the American plants, the waste heat boiler has been adopted quite generally. This combination has heretofore given the most efficient utilization of fuel. European plants have installed some of these boilers, but their lower rate of operation, with its correspondingly higher fuel economy, leaves less heat in the exit gases and thus makes the saving due to the boiler considerably less than under American conditions. The introduction of the boilers does not increase the fuel economy of the kiln, but decreases the losses by recovering the heat and utilizing it for generating the power to operate the manufacturing process. Thus the combined efficiency of heat utilization of the kiln and boiler may be quite good, even though the kiln efficiency itself may be rather poor. The two processes work in opposite directions. Good kiln operation leaves too little heat in the gases to satisfy the power requirements. Thus the economical operation of the waste heat boiler plant, with a high power recovery, necessitates uneconomical kiln operation. The tendency to generate all the power from the waste heat boilers encourages the burning of excess fuel in the kilns in order to balance the power demands. The burners sometimes become quite skilful in burning with a deficiency of air and carrying continuous secondary combustion with the air leakage at the seal rings and in the connecting flues. In this way they avoid severe scouring of the kiln linings in burning the extra coal.

Large Investment in Generating Plant

The economical generation of an adequate amount of power and the maintenance of low generation costs involves close supervision, and it either requires higher technical ability than is usually allowed, or diverts a considerable amount of the attention of the plant management away from the principal manufacturing process. An entire new department with a process of a widely different nature requiring skilled operators must be organized, correlated and co-ordinated with the manufacturing processes of the various departments, and supervised.

A large investment is required to cover all the various equipment which goes into a modern generating plant. The continuous nature of the operations necessitates a rather complete water treating plant for the boiler feed. Adequate supplies of condensing water must be included. Steam and electrical equipment for power generation, and means for the collection and disposal of the dust from the gases, all require capital which may return a higher percentage if invested in the main process. The history of large-scale power production has warranted the assumption that constantly reducing costs offer a diminishing rate of return through the difference between the cost of waste heat power generation and purchased power. It is even conceivable that, during the life of existing plants, rising costs of generation in the smaller plant and the economies of the central station may eliminate this difference entirely.

The correlation of the widely divergent demands for power and clinker is a problem of large magnitude for



The powdered raw material is discharged from a bin (1) by means of a double screw feeder (2). A bucket elevator (3) conveys the material to a small feed bin (4), from which an absolutely uniform feed is arranged into the Hydro-baller (5), a rotating drum with an inside water spray system which, by the combination of its rotation and the fine water spray, transforms the dry raw meal into nodules or small balls about the size of marbles. These nodules pass to a feeding hopper (6) from which they are fed uniformly at a predetermined depth to the enclosed sintering grate (7). The slowly traveling grate discharges the heated and partially calcined raw feed to the rotary kiln (8) at a rate which may be altered to suit the requirements of burning. This speed adjustment is obtained by varying the speed of the motor driving the grate. From the kiln the clinker will pass to the cooler in the usual manner.

The kiln gases are drawn by the exhaust fan (10) through the layer of nodulized material on the grate (7) and discharged into a vent stack (11). During the passage through the layer of material, the contact of the gases with the material is so intimate that the temperature of the gases is reduced from 1,650 deg. F. to around 300 deg. F.

Any material passing through the grate openings will be collected in the gas-tight dust bins (12) and is returned by the screw conveyor (13) to the elevator (3). On top of the grate chamber is the auxiliary stack (14) with a top damper. This stack is used only for starting the kiln. The kiln may be fired by oil, gas, or coal, as desired, although coal firing is shown in this illustration.

Figure 2. Short rotary kiln with sintering grate and auxiliary apparatus

the plant management. There is a great tendency on the part of the operating personnel to look on the power recovered from the waste heat in the gases as something obtained for nothing, and this power is used extravagantly. During those periods when clinker is being stored there is usually a surplus of power, but when it is necessary to grind clinker at a higher rate than it is being burned, power is always deficient. At such times the kilns must be operated for the generation of power, disregarding entirely the economic requirements of burning. The power department, being the intermediate, is constantly in trouble because of excessive demands for heat on the one hand, and deficient power supply on the other.

Many Expedients to Attain Fuel Economy

In those plants where the generation of by-product power has not been economically justified, many expedients have been tried. The kilns have been lengthened, chains have been installed in the feed end, and other means of increasing the heat transfer have been used. In the wet process, filters and other means of dewatering the slurry have been introduced to eliminate a part of the heat necessary for the evaporation of the water. Filters have also been used to make a greater amount of the heat available for recovery in the waste heat boilers.

European manufacturers have approached this problem from a different angle. The high forcing rates of the American kilns are looked upon as wasteful. The longer life of the cheaper linings and the less amount of fuel required with the lower output rates receive more attention, while less thought is given to the carrying charges and overhead expenses. Under these conditions the operations are less favorable toward the waste heat boiler. The plants are generally smaller in size, and frequently several different kinds of cement are made in one plant. The general requirements are different and the resulting different mental viewpoint has brought other treatment in the development of process and equipment.

Never Abandoned Shaft and Ring Kilns

Europe has never abandoned the shaft and ring kilns in the wholesale manner in which the American industry did, following the introduction of the rotary kiln. The increased fuel consumption of the latter always seemed to the European engineers as a step in the wrong direction; and with their comparatively small plants, their low labor and high fuel costs, it was obviously wrong for them in many cases. As a result they have retained and improved upon the shaft kiln, till they now have a continuous shaft kiln which combines the high fuel economy with a low labor cost and the continuous process. The units erected to date have been small, and considerable development will be required before they will be generally acceptable to the American industry.

A recent development in Europe, which now has several years of commercial operating experience behind it, is

the combination of the rotary kiln with a traveling sintering grate. This combination gives every promise of a highly successful solution of the fuel problem. The thermal principles are good and the working out of the mechanical details is very satisfactory. The material is first nodulized with about 10 per cent of water. It is fed in the form of small balls, about the size of a marble, through a feed hopper to the grate. The hot gases are drawn down through the layer of nodulized material and exhausted through a suction fan. In passing through the material the moisture is dried out, the material is heated and the top layer is calcined almost completely with a decreasing amount of calcination in the lower layers.

The material as fed to the kiln, therefore, is approximately 30 per cent calcined and will nearly all be at the calcining temperature. This reduces the work to be done in the kiln, and thus a shorter kiln and less fuel will be required in the burning of the clinker in the rotary kiln. Advantage is taken of the high heat transfer, incident to the intimate contact of the gases with the material and to the partial vacuum to induce the draft, to accomplish this result with a lower temperature heat than would be possible in the rotary kiln, and thus more economically. The exit gases are discharged at approximately the same temperature as the gases from the waste heat boiler; but as there is a smaller weight of gases per barrel of clinker burned, the total amount of heat wasted with the gases will be considerably less. The heat absorbed in the calcination of the raw material is the largest item of heat absorbed in the chemical process of burning. Thus any heat used in this manner from the waste gases is clear gain, since it replaces a larger amount of high temperature heat. The relatively large amount of heat absorbed in the dissociation of the carbon dioxide accounts for the very rapid cooling of the gases in the first few inches of the layer of material.

New Process Is Simple

This process is quite simple and involves only the process of burning clinker. There is no question of adjusting the burning of the kiln to the amount of power wanted at that particular time. The minds of the operators will be concentrated upon the economical production of their own product. There is no complicated process introduced to require skilled labor. The relationship is better coordinated with the customary process of burning. The apparatus is no more complicated than many of the kiln feeding mechanisms now in use. The adjustable speed of the grate gives a very convenient means of controlling the output of the kiln. Maintenance and repairs have been reduced to a minor factor. In some plants the grates have operated for a year without requiring the replacement of a single plate.

Has Many Secondary Advantages

There are a number of secondary advantages which have a very beneficial effect upon the operating costs of the other departments as well as the burning department. Some of these can not be evaluated, but many can be shown on the cost sheet. The reduction in the fuel used will permit the use of a fuel preparation plant approximately one-third smaller in size, with a corresponding reduction in the erection and operating costs. Where this system has replaced the previous methods of burning in operating plants, an average reduction of 10 per cent has been found in the amount of raw material required to make a barrel of clinker. This corroborates the average amount of dust loss with the kiln stack gases as given by various investigators who have measured the actual material recovered by dust collecting equipment. This dust collecting feature is inherent in the process. It removes all the objectionable dust from the gases. Thus the advantages of modern dust collecting equipment are obtained without additional financial outlay.

How Dust Is Removed From Gases

The underlying reason for the thorough nature of the separation of the dust from the gases is quite simple. When the dust-laden gases are passed through the layer of nodulized material in extremely small streams, they are brought into intimate contact with the surfaces of the nodules. During this contact practically all the dust will be deposited on the surface of the nodules. The small amount which filters through the grate is mostly coarse particles which have broken from the surfaces of the nodules and is comparatively easily settled from the gas stream. The gases leaving the stack are not visibly cloudy. Thus the dust loss through the stack is quite small.

Some Trouble With Alkali Salts

In some cases a considerable percentage of alkali salts are introduced with the raw materials. These salts are not bothersome unless they concentrate in the flue dust which is returned to the kiln feed. They appear as the gases are cooled in extremely small particles of sublimate, probably starting as molecular in volume. Gradually

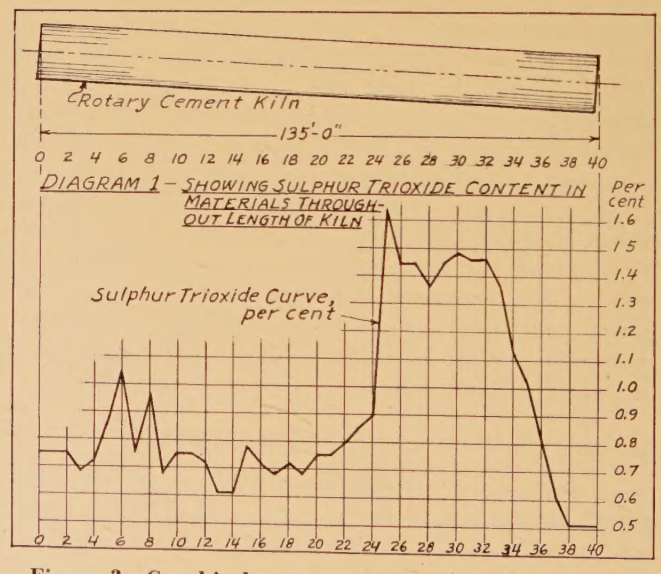

Rotary Cement Kiln
135'-0"
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
DIAGRAM 1 – SHOWING SULPHUR TRIOXIDE CONTENT IN MATERIALS THROUGHOUT LENGTH OF KILN
Per cent
Sulphur Trioxide Curve, per cent
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40

Figure 3. Graphical representation of sulphur trioxide content throughout length of kiln

they agglomerate till they become of sufficient size to be deposited from the gas stream. In this process the gases are cooled in passing through the bed of nodulized material on the grate. The time of passing through this layer is very small. Thus the alkali salts do not have the necessary time to agglomerate till after the gases have

(Continued on page 62)

Electric Dewatering of Slurry Under Four-Year Test[1]

Bureau of Mines Conducts Four-Year Tests with Clay-Limestone Slurry—Fundamentals of Electrical Dewatering—Requirements for Dewatering Machine

By HEWITT WILSON[2] *and* H. G. WILCOX[3]

The dewatering of cement slurry by electricity has been under test for a period of four years, at the Northwest Experiment Station of the U. S. Bureau of Mines. At the request of *Concrete* a full description of the results of the investigation has been prepared by the authors for publication in the Cement Mill Edition.

The present installment covers the principles involved in dewatering by electricity. There are also brief references to previous investigations, and a statement of the requirements of a machine for dewatering cement slurry.

Next month's installment will contain a description of the scope of the investigation and the test methods employed. The final article will include, among other things, statements of cost and of power requirements.

This series will be read with close interest by operating officials.—The Editors.

THE removal of clay from suspension in water by the use of electricity has been studied for the past four years at the Northwest Experiment Station of the United States Bureau of Mines, in co-operation with the University of Washington. The study has been developed by several research fellows, Vance S. Cartwright, Howard S. Davis, and Carl E. Curtis. The report[4] prepared by Curtis in 1930 contained a resumé of previous work on electrophoresis, a discussion of some colloidal theories in relation to electrophoresis, and the experimental results obtained when using Washington kaolins. The present report is a continuation of this study applied to the dewatering of portland cement slurry.

Sources of Economy

That dewatering cement slurry before firing produces a saving in the cost of manufacture is attested by the number of filters which have been installed in the past four years. Beneficial results from the use of filters are claimed to be as follows:[5] (1) Reduction in fuel; (2) increase in kiln capacity; (3) more uniform clinker; (4) elimination of mud rings; (5) better raw grinding; (6) increased power from waste heat boilers; (7) utilization of flue and precipitator dust; and (8) a saving in water. The continuous type of filter is that generally installed, and the question of changing to the use of electricity for dewatering will depend on the relative cost and efficiency of dewatering by the two methods.

Grateful acknowledgment is given to Dean Milnor Roberts of the College of Mines, University of Washington, H. F. Yancey, acting supervising engineer of the Northwest Experiment Station, U. S. Bureau of Mines, and H. V. Tartar, of the department of chemistry, University of Washington, for valuable assistance. The Pacific Coast Cement Company, of Seattle, furnished the material for the tests and gave information concerning its methods and products. The electrical engineering department, University of Washington, co-operated by loaning certain equipment.

Resume of Previous Investigations

DEWATERING BY FILTER PRESS

Harsh[6] reduced the water content of a cement slurry with a continuous filter from 35 to 19 per cent and mixed the filter cake with the Cottrell precipitator dust in a pug mill before feeding to the kiln. He stated that "the additional steam available from the waste heat boiler by reason of the higher temperatures of the waste gases is several times that required to generate the electric power necessary to operate the filter and its auxiliary equipment."

Schaffer[7a] reports the results obtained in 16 cement manufacturing plants where slurry filters had been installed. In nine of these plants the water content before filtering ranged from 33 to 36 per cent, and after filtering the range was from 16 to 19 per cent. In the remaining plants the water content before filtering ranged from 36 to 50 per cent, and after filtering the range in this group was from 18 to 28 per cent.

[1]Published by permission of the Director, U. S. Bureau of Mines. (Not subject to copyright.)

[2]Engineer (non-metallics), U. S. Bureau of Mines, Northwest Experiment Station, Seattle, Wash.

[3]Research fellow, U. S. Bureau of Mines, Northwest Experiment Station, Seattle, Wash.

[4]Curtis, C. E., The Electrical Dewatering of Clay Suspensions: *Jour. Am. Ceramic Soc.*, vol. 14, 1931, pp. 219-263.

[5]Robinson, A. W., Development in Filtration of Cement Slurry: *Rock Products*, Vol. 34, No. 1, 1931, pp. 153-154.

[6]Harsh, E. C., Experience with Slurry Filters: *Rock Products*, Vol. 33, No. 11, 1930, pp. 51-54.

[7a]Schaffer, H. A., Filters in Wet Process Cement Plants Save Fuel: *Cement Mill Edition* of CONCRETE, Vol. 36, No. 3, 1930, pp. 109-112.

At the Manitowoc (Wis.) plant of the Medusa Portland Cement Company[7b] the water content of the cement slurry is being reduced from 33 to 19 per cent.

The following results were obtained by the Dewey Portland Cement Company, Davenport, Iowa:[7c]

	Open circuit without filters	Open circuit with filters	Closed circuit with filters
Slurry moisture, per cent	36	36-40	45
Filter cake moisture, per cent		18	19-20
Plant output, barrels	4,500	5,600	6,600
Fuel rate, pounds	135	110	120-130

A. W. Robinson[8] states that 19 plants with 48 kilns and an annual production (1930) of 22,100,000 barrels are now using filter installations. Five plants installed slurry filters in 1930. Robinson gives a description of the plants in which such installations have been made.

DEWATERING BY ELECTRICITY

The electrical method of dewatering suspensions was developed about 1901 by Count Botho von Schwerin, who used the process for the extraction of water from peat, fire clays, and kaolins. Three clay companies are now using the electrical method on a commercial scale in Saxony, East Prussia, and Czechoslovakia. Curtis[9] gives a complete description of Schwerin's patents and their commercial use.

Some Fundamental Facts

Previous work with clays disclosed that:

1. When a direct current of electricity is passed through a suspension of clay in water, the clay particles, which carry a negative charge, pass to the anode and collect there in such a compact layer that the water content of the mass withdrawn from the suspension is lower than that of the original slip. Like the filter press, this removes only a portion of the water and changes the fluid suspension to a plastic mass.

2. A mixture of clay and other finely-divided particles is deposited on the anode in the same proportion as that in which they will remain in suspension. It was thought by certain investigators that certain colloidal impurities could be removed by a selective action of the electric current, but Bleininger[10] in his work at the U. S. Bureau of Standards found that even positively charged hydrated ferric oxide was dragged along with the negative clay particles without separation. Cement slurries consisting of ground limestone supported by clay particles in water are impure clay suspensions. All of the limestone particles except the finest will settle readily without the assistance of a supporting colloid. The colloidal clay particles, though present in a smaller amount by weight, coat the coarser and smaller number of limestone particles and help carry them to the anode without separation.

3. A single passage of the slurry through the electrophoresis machine will not remove all the solids. The partially depleted suspension is repeatedly re-used in closed circuit with the grinding and dewatering apparatus.

4. Investigators have found that the clay particles travel with less electrical power, are packed into tighter masses with less water on the anode and that the whole process is more efficient when the clay particles are dispersed with an alkali such as sodium silicate, sodium carbonate or sodium hydroxide, which decrease viscosity and increase fluidity. In most cases a smaller amount of water can be used in the original blunging or grinding if the slurry is properly dispersed. The most effective type and amount of alkali varies with the individual clay, but usually only a few tenths of 1 per cent are needed. The increase in fluidity must not be great enough to permit a differential settling of the limestone particles. However, if this happens, the water content of the slurry should be reduced.

Hall's Investigations with Cement Slurry

Hall[11] investigated the electrical dewatering of cement slurry. He gave the following "factors of the process":

(1) The opposite charges on the liquid and solid are probably due to the "electrical double layer," which is a purely surface effect; hence, the efficiency of the process depends on the amount of surface exposed.

(2) The velocity of the particles approximates that of ions and increases with the voltage.

(3) The degree of dehydration is a function of the voltage.

(4) The amount of material removed is proportional to the amperage.

(5) The efficiency of the process is directly proportional to the fluidity.

Hall describes the application of these factors and five electrophoresis machines in which the process can be applied. He states that the completeness of unwatering is dependent on the voltage and nothing else. Thus, in experimenting with clay, he obtained a deposit which was very wet at 30 volts but at 1,000 volts was very dry. There is an economic limit, however, to the voltage that can be used, due to the loss of current through electrolysis of the water at higher voltages.

Factors in Efficiency of Process

In comparing cement slurries with clay suspension, Hall points out that they differ because cement slurries contain two materials (clay and limestone) with opposite electrical tendencies. The clay tends to go to the anode while the limestone tends to be attracted by the cathode.[12] Since, however, mutually adsorptive materials tend to go to the same pole, both the limestone and clay pass to the anode unless the electric potential ruptures the adsorption bond.

An important factor in the efficiency of the process is the fineness of the particles. Clay particles approach colloidal sizes, but most of the limestone particles are much coarser and are apt to settle readily. This behavior can

[7b]Slurry Filters Save Fuel in Manitowoc Plant: *Cement Mill Edition* of CONCRETE, Vol. 40, No. 1, 1932, pp. 51-53.

[7c]Rock Products, First Closed-Circuit Wet-Process Cement Mill: *Rock Products*, Vol. 33, No. 25, 1930, pp. 65-67.

[8]See footnote 5.

[9]See footnote 4.

[10]Bleininger, A. V., Use of Sodium Salts in the Purification of Clays: U. S. Bureau of Standards, Technol. Paper 51, 1915.

[11]Hall, L. G., Electrical Unwatering of Portland Cement Slurry: *Cement Mill and Quarry* (now *Pit and Quarry*), Vol. 32, Nos. 9, 11, 12, 16 (May, June, Aug., and Dec.), (1928).

[12]In the present investigation at Seattle several pulverized limestones were drawn to the anode and not to the cathode, as indicated by Hall.

be overcome by placing the electrodes in such a way that the one toward which the materials travel is at the bottom, thus obtaining the combined effect of gravity and of the electrical difference of potential.

Requirements of Machine for Dewatering Slurry

A machine for large-scale unwatering to meet these conditions should have the following characteristics:

(1) Continuous operation.

(2) Electrical precipitation in a downward direction.

(3) Provision for intimate contact of the whole of the slurry, first with the upper cathode, then with the lower electrode (anode), taking the form of a gentle flow from the former to the latter.

(4) Provision for removing the precipitated solids from the liquid without violent washing action.

(5) Provision for draining the loose surface water from the solids after removal from the water.

(6) Provision for the escape of gases with as little disturbance as possible.

(7) A decreasing distance between the electrodes in the direction of flow of the liquid, to compensate for the increased resistance of the latter as the amount of suspended matter decreases.

(The next installment will describe the scope of the investigation and the methods of test employed.)

High-Quality Cements No Monopoly of Large Production Units

Predominating Importance of Fineness and Uniformity of Raw Mix and Skill in Burning—Points on Choice of Fuel

By E. LEDUC
Honorary Chief of Section of Materials of Construction of the National Conservatory of Arts and Trades, Paris

(Continued from March issue)

IN the March issue the writer discussed the relative value of the composition of raw materials, on the one hand, and the fineness and uniformity, on the other, and proved the latter to be of much the greater importance. Cases were cited also where high-early-strength cements are obtained with normal lime content.

The present article emphasizes further the predominating importance of fineness and uniformity in the raw materials and the need for skill in burning.

Results With High Lime and Low Silica

Back in 1905 we tested a cement produced by accident —probably in a vertical shaft kiln—from some fine and homogeneous materials, in which the lime content was notably high. The analysis of the clinker was as shown in Table 8.

The expansion of the clinker taken at the cooler discharge was nil. The quantity of lime—67.20 per cent—is equal to that theoretically necessary (67.46 per cent) to transform the total quantities of silica, alumina and iron oxide into their respective tricalcium combinations. On the other hand, the silica coefficient was low. In spite of the high percentage of lime, the strength was no higher than that of the general run of good cement of that period.

TABLE 8

Analysis of Clinker Produced by Accident

	Per Cent
Silica, combined	18.55
Alumina	7.29
Iron oxide	3.47
Lime	67.20
Magnesia	0.79
Sulphuric anhydride	0.33
Insoluble materials	1.42
Loss on ignition	0.48
Undetermined	0.47
Total	100.00
Hydraulic coefficient	2.29
Silica coefficient	1.73

Soundness With High Lime

In some industrial tests conducted at the Teil plants by Jules Bied, that investigator succeeded, upon burning at a very high temperature in a gas-fired kiln, in manufacturing a cement that remained stable in boiling water, and of which the analysis was as given in Table 9.

As will be seen, the hydraulic and the silica coefficients are very high.

Later Bied demonstrated at the same plant that, under the influence of prolonged burning, one may overload a cement with lime without creating a tendency toward expansion on that account. This process has not been given any industrial application. The clinker obtained contained 20.25 per cent of combined silica, 2.00 per cent

of alumina, 1.62 per cent of iron oxide, and 71.50 per cent of lime, while the quantity of lime necessary to transform the silica, the alumina and the iron oxide completely into their tricalcium compounds is only 61.70 per cent.

Fineness and Uniformity of Greatest Importance

These examples are peculiarly typical and show clearly the needlessness of increasing the hydraulic and the silica coefficients, on condition that minute care is exercised in preparation for burning; and also, as we shall emphasize farther on, in the employment of a suitable fuel. The strength of the cement depends much more on the fineness and the uniformity of the raw mixture than on the chemical composition. It is for this reason that the cement plant at Xeuilley is able, through double burning, to manufacture a cement of the first quality with raw materials having relatively low hydraulic and silica coefficients.

TABLE 9

Analysis of Clinker Burned at High Temperature in Gas-Fired Kiln

	Per Cent
Silica	23.30
Alumina	2.40
Iron oxide	0.90
Lime	70.70
Magnesia	1.40
Loss on ignition	1.30
Total	100.00
Hydraulic coefficient	2.65
Silica coefficient	7.06

Using Skill in Burning

If it is possible to increase the hydraulic coefficient through skill in burning, it is likewise possible to diminish it, just as the silica coefficient may be increased by utilizing siliceous material, or better still, through the addition of silica of a special form.

We have shown that by adding a small supplementary quantity of clay (3 per cent) to a normal cement paste having a hydraulic coefficient of 2.05, with the view of reducing it to 1.72, the production of inert dust was negligible when the added clay was finely ground. In this test the burning took place in a gas-fired kiln. The dust produced was separated from the clinker some hours after burning, before the latter had been moistened.

Searching for Resistant to Sea Water

We likewise demonstrated, in 1908, that by employing gaize as the siliceous raw material, extremely curious results were obtained. To obtain this cement we burned in a gas-fired kiln a raw mixture of hydrated lime and gaize. We therefore, in effect, operated by the double burning process.

This test had as its object the manufacture of a cement which, for our purpose, was to be resistant to decomposition by sea water. From this point of view the process produced no results, because the cement was decomposed the same as ordinary cements. On the contrary, these tests did demonstrate that it was possible to manufacture a cement with a low hydraulic coefficient and an exceptionally high silica coefficient without the production of dust in the burning process. Besides, this cement developed a strength which, at that period, was very satisfactory.

As may be known, the gaize is a soft puzzolanic material, very abundant in certain regions of France, in which the silica is found in a soluble form. The analyses of two samples, after very slight calcination, were as shown in Table 10.

TABLE 10

Analyses of Two Samples After Slight Calcination

	First Sample	Second Sample
Silica	80.20	76.20
Alumina	8.30	7.70
Iron oxide	3.60	3.20
Lime	2.20	5.00
Magnesia	1.20	1.08
Sulphuric anhydride	0.54	0.74
Loss on ignition	4.25	5.50
Undetermined	.....	0.58
Totals	100.29	100.00

The analyses of the clinkers produced from the two samples were as given in Table 11.

TABLE 11

Analyses of Clinker from Two Samples

	First Sample	Second Sample
Silica	31.630	30.018
Alumina	2.055	2.609
Iron oxide	1.053	1.237
Magnesia	1.370	1.566
Lime	63.173	63.306
Sulphuric anhydride	0.511	0.744
Loss, and undetermined	0.558	0.520
Totals	100.000	100.000
Hydraulic coefficient	1.82	1.87
Silica coefficient	10.20	7.80

In these two cements the lime content is far from the quantities required—91.84 for the first and 84.80 for the second—for the transformation of all the silica and the alumina into their tricalcium compounds. This condition is the reverse of certain cements previously cited. Nevertheless, the clinkers were not pulverized of their own accord, but remained intact. The strengths developed by this cement were of the first order for their period, as shown in Table 12.

TABLE 12

Strength of Cement Shown in Table 11, *in Lb. per Sq. In.*

	Neat Cement		1:3 Mortar	
Age	Tension	Compression	Tension	Compression
7 days	285	3,630	218	2,730
28 days	583	8,620	299	4,110

To appreciate the value of this cement (Table 12), it is only necessary to recall that at the time of these tests the specifications of the ministry of public works required a 7-day strength of only 114 lb. per sq. in. in tension, for 1:3 mortar.

Highly Siliceous Cements

As will be seen, the last three cements cited above are highly siliceous. They are differentiated from each other chiefly by their hydraulic coefficients, 2.65 in one case, compared with 1.82 and 1.87 in the other two.

Later, in a test made under manufacturing conditions, we made some cement in automatic vertical shaft kilns, after a process developed by Hans Kuhl. The chemical analysis of the clinker was as indicated in Table 13.

TABLE 13

Analysis of Clinker Made After Process Developed by Kuhl

	Per Cent
Silica	17.60 to 19.40
Alumina	7.95 to 9.00
Iron oxide	5.00 to 6.00
Lime	60.00 to 62.00
Hydraulic coefficient	1.70 to 1.93
Silica coefficient	1.15 to 1.45

Overcoming Disadvantages of Shaft Kiln

The disadvantage of this method of manufacture, in vertical shaft kilns, lies in the fact that the calcining zone is in close proximity to the clinkering zone. There is always the danger of damage to the kiln discharge apparatus. Nevertheless, by taking certain precautions we have made close to a thousand tons without any damage whatever to the kiln. However that may be, the strengths obtained were those of a high-grade cement.

Wide Latitude in Chemical Composition

It will be seen by these examples that a wide latitude may be permitted in the percentage of the essential constituents of cement. This is explained, in the first place, because in consequence of the size of the particles and the more or less uniform character of the raw meal the mass of the composition does not form all of the hydraulic combinations; and second, because the clinker contains several components at present only more or less clearly defined.

According to the authors, it may be acknowledged that—

(1) A basic silicate $SiO_2.3CaO$ or $SiO_2.2.5CaO$ or $SiO_2.2CaO$, the latter two absorbing by dissolution a quantity of lime such that the total will exceed the 3CaO of the tricalcium combination. We demonstrated in 1901 that a cement when reheated for a period of 48 hours at a temperature ranging between 900 and 1,000 deg. C. gave up a large proportion of lime, and that there was nothing left but a mixture of dicalcium silicate and of lime. In comparing this phenomenon, as Hendrickx has done, to that of the devitrification of glass, one is inclined at least to admit the possibility of the solution of the lime in the dicalcium silicate.

According to Rankin, the dissociation continues up to 1,900 deg. C.

(2) The silico-aluminous calcium compounds, for example, the alite of Janecke, to which this experimenter has given the formula $2SiO_2.Al_2O_3.8CaO$.

It is, however, permissible to say, without delving thoroughly into this formula, that it is certainly in error, inasmuch as Henri Le Chatelier has shown, without a possible doubt, that the grappier cements of Teil, which have the micrographic constitution of portland cement, contain only a negligible proportion of alumina.

The alite of Janecke is somewhat intermediate between the crystals recognized by Le Chatelier in the grappier cements of Teil, designated as alite by Tornebohm, and the vitreous mass called celite by Tornebohm. A distinguished chemist, Campbell, has undertaken to prepare alite and celite. Unfortunately, the procedure employed has introduced magnesia. The chemical compositions of these two compounds are given in Table 14.

TABLE 14

Chemical Composition of Alite and Celite

	Alite	Celite
Silica	23.34	15.37
Alumina	1.76	11.69
Iron oxide	0.74	3.50
Lime	71.14	61.40
Magnesia	2.91	7.04

(3) Possibly the silico-aluminous-ferric calcium compounds.

On the part of the tricalcium silicate, the following composition prevails:

Silica	26.39 per cent
Lime	73.61 per cent

If, on the contrary, the formula given by Janecke for alite is taken, we have:

Silica	22.16 per cent
Alumina	7.61 per cent
Lime	72.21 per cent

Such a proportion of alumina is never encountered in the grappier cements of Teil.

Chemical Composition May Vary

The chemical composition of the clinker resulting from these formulas may therefore vary within wide limits, so much the more since these compounds themselves are dissolved in each other in various proportions, and are, moreover, mixtures of the products of fusion. In reality, the cement is a mixture of various products.

There is present, therefore, a material rich in hydraulic products. The difficulty in putting them to use lies in processing those which are particularly active in the raw materials, and in choosing the methods by which they are prepared.

Points on Choice of Fuel

As we have stated previously, the selection of a suitable fuel is of great importance.

If the raw materials are dissimilar, and especially if there is an addition of sand or of slag, it is preferable, where vertical shaft kilns are employed, to burn solely with coke.

At the small plant in Spain, to which reference was made at the beginning of these articles,[1] nothing but coke was used.

If, on the contrary, the raw materials approach closely to the ideal theoretical proportions and are composed of extremely fine particles, it will be possible to burn with anthracite only, selecting coal with as low an ash content as possible.

Use Mixture of Coke and Anthracite

In a cement plant where we found it necessary to add a rather large proportion of siliceous sand to the raw materials, we have attempted at different times to burn with anthracite only, instead of burning with a mixture of coke and anthracite.

Whenever we have burned with the mixture of coke and anthracite we have obtained very good clinker. When, on the contrary, we burned solely with anthracite, the clinker was of inferior quality. After a run of three or four days the clinker began to come out of the kiln in a white hot condition, similar to its condition in glass-blowing. The more badly it was burned, the more was the kiln out of order and the yield diminished.

Try Anthracite Alone

In a burning test run of several weeks with anthracite alone, which we observed with special care, the granulometric composition of the clinker after several weeks of storage was as shown in Table 15.

TABLE 15

Granulometric Composition of Clinker Burned with Anthracite Only

	Weight in lb. retained from 100 lb. of clinker	Specific gravity	Lime (in lb.) soluble in sugar solution
Retained on 5 m/m sieve (about 3/16 in.)	38.0	3.18	5.5
Retained on 1 m/m sieve (about 1/32 in.)	17.0	3.12	5.1
Retained on sieve with 45 meshes per lin. in.	9.0	3.04	6.1
Retained on sieve with 76 meshes per lin. in.	8.5	2.99	7.1
Retained on sieve with 178 meshes per lin. in.	9.7	-----	-----
Passing the 178-mesh sieve	17.8	2.77	14.5
	100.0		

It will be seen that the finely pulverized material which passed the 178-mesh sieve is nothing less than a hydraulic lime which gave up 14.5 lb. of lime to the sugar solution.

Each time that we have attempted to substitute the other fuel in place of coke the clinker behaved as the above example demonstrates. We always obtained much more dust than clinker.

[1]February (1932) issue of the *Cement Mill Edition* of CONCRETE, page 56.

(To be concluded)

Government Award to Tampa Plant Is Mill's Largest

The largest single order the Florida Portland Cement Co. plant at Tampa has ever received was that for 100,000 bbl. of cement awarded it in February by the federal government.

The cement will go into the Madden dam, being built to impound the water of the Chagres river as a reserve supply for operation of the Panama canal.

Delivery will be made in eight monthly shipments of 12,500 bbl. each, beginning in May. It will be carried by the Houston-Panama mail steamship of the Lykes Brothers Steamship Co., which will call at Tampa probably on the southward trip.

Nebraska Plant Re-Employs Large Force Upon Reopening

The Nebraska Cement Company, at Superior, Nebr., started operations on March 16, after having been idle for several months. A large force was given employment.

Peerless Plant Reopens

The Port Huron, Mich., plant of the Peerless Portland Cement Co. resumed operations on March 15, employing 100 to 125 men.

Sintering Grate and Rotary Kiln Gain Fuel Economy

(Continued from page 56)

passed beyond the bed of material. The small percentage of dust which passed out the stack is largely composed of these finely divided particles of sublimated alkali salts.

One very interesting example of the versatile nature of this process is the kiln which has been installed for the I. G. Farben industry in their plant at Lever Kusen, near Cologne, Germany. In this plant the raw materials are sulphates which are decomposed by the heat in burning. The burned material is so proportioned chemically as to produce a very good grade of cement clinker. The gases, after giving up their heat in the layer of nodulized material, are conducted to another department where the high percentage of SO_2 is removed and converted into sulphuric acid.

The comparatively small amount of SO_3 which remains in the clinker after passing through the burning zone where a reasonably hard burned clinker is being prepared is shown in Figure 3, which has been reproduced from an article by Alton J. Blank in the October (1930) Cement Mill Edition of CONCRETE, page 82, second column. This chart, which is designated in that article as Diagram 1, gives a graphical representation of the SO_3 content throughout the length of the kiln. The comparatively small amount of sulphur trioxide remaining in the clinker is of negligible importance. Thus the effect of the small amount of sulphur trioxide formed in the combustion of the coal may be neglected as of insufficient magnitude for serious consideration.

EDITORIAL

Will Our Burning Processes Be Changed?

WILL American cement manufacturers change their burning methods? If so, will they turn to the shaft kiln, now modernized, or to a more recently developed combination of a sintering grate and short rotary kiln, or to some method still under development?

Modernized shaft kilns of the types now employed in European cement plants are admittedly better suited to plants of small and medium size than to the larger units commonly found in the United States and Canada; but as T. H. Arnold suggests in an article in this issue, further development of the shaft kiln may make it practicable for American use.

The fact is that recent improvements in shaft kilns, coupled with increased heights, have more than doubled their capacity and greatly improved the quality and uniformity of the output. These facts are well demonstrated in articles published in our issues of October, November and December (1931). In one case a group of four reconstructed and modernized shaft kilns, each 11 ft. 6 in. in diameter and 41 ft. high, developed a daily output of 100 metric tons (586 bbl.) of clinker per kiln, about equal to the production of a rotary kiln 7½ by 125 ft. in dry process operation. Before the reconstruction of these shaft kilns their output was only half as much.

In a new Swiss plant two shaft kilns of the most modern type, each 8 ft. 3 in. in diameter and 33 ft. high, are daily producing 140 metric tons (820 bbl.) of clinker per kiln. This approaches closely the production of a rotary kiln measuring 8 by 150 ft., under dry process operation.

From the two instances given it must be clear that the shaft kiln of today is in no way to be compared with the older kilns of this type. On the other hand, the American cement industry has an enormous investment tied up in rotary kilns, and manufacturers will be in no mood to scrap them. For this reason it would appear that a change to the burning process that utilizes a sintering grate and a short rotary kiln, or to some similar method, might be less painful than a return to the shaft kiln. At least a part of the rotary kilns now in operation could be utilized.

The sintering grate-rotary kiln process was first described in our issue of September, 1931. In the present issue it is described in considerable detail by T. H. Arnold, who discloses the fact that it is in actual commercial operation in some eight or ten plants in Europe. Only about half as much fuel is required as in dry process rotary kiln operation, and the power consumption is no greater.

It is certain that forced production, which means high fuel consumption per barrel, is no longer consistent with economical operation. Fuel continues to hold its place as the largest single item of cost. The possibility of cutting this item in two is a matter that deserves careful study and consideration, from the standpoint of each individual plant.

Growth of Bulk Shipments by Water

THE use of water transportation for shipment of cement, in vessels designed and equipped especially for the purpose, has received definite encouragement in several recent actions taken by the Marquette Cement Manufacturing Co.

First came the announcement of the decision to extend the company-owned tow-barge service from Memphis, Tenn., to Vicksburg, Miss. Last year these barges operated from Memphis to Peru, Ill., utilizing the Mississippi and the Illinois rivers.

More recently the same company announced its plans for barge shipments of cement to Chicago, upon completion of the new Illinois waterway.

A number of cement companies have taken advantage of water routes for bulk transportation from mills to distributing warehouses. The gradual growth of this form of transportation is based on its proved merits.

Reduce Blasting Cap Accidents to Children

FIGURES available for 1931 show a decrease of ten per cent in the number of blasting cap accidents to children, as compared with the preceding year. Perhaps an even greater reduction can be made this year. The Institute of Makers of Explosives is now making another appeal to all those who use blasting caps to see that they do not fall into the hands of children. At this time of the year these accidents tend to show an increase because children play more out of doors.

The campaign to warn children of the danger of playing with blasting caps, and to warn adults of the danger of leaving the caps where children might find them, was started five years ago. It has been participated in by trade and technical papers, newspapers, press associations, boy scouts, girl scouts, school authorities and many other organizations.

The quarry branch of the cement manufacturing industry has co-operated in this worthy effort, and is thus encouraged to continue this co-operation.

Physical Properties of Tricalcium and Dicalcium Silicates

Study of Chemically Pure Compounds Reveals Rates of Hardening, Freedom from Volume Changes, Mixing Water Required, and Other Properties

By D. L. SNADER
Research Fellow, Columbia University, and Professor of Civil Engineering, Stevens Institute of Technology

In this first installment of D. L. Snader's study of the compounds assumed by many investigators to be the main constituent chemical components of commercial portland cements, the author deals with the physical properties, characteristics and qualities of chemically pure tricalcium silicate and dicalcium silicate.

Chemically pure tricalcium aluminate and dicalcium ferrite will be the subjects of the next installment.

These articles by Mr. Snader are slightly condensed from Part II of Bulletin No. 4, Department of Civil Engineering, Columbia University, New York. Part I of the same bulletin, by R. J. Colony, which appeared in the February and March issues of the Cement Mill Edition of "Concrete," described the preliminary studies made with chemically pure compounds, and the application to commercial portland cements of the results of those studies.

The collaboration between these two able investigators has served to clear up some of the doubtful points about the chemical components of portland cement.—The Editors.

THE solution of the causes which under certain conditions result in disintegration of concrete structures can only be found by an intensive study of the hydration products and hydrolysis of portland cement. An intensive study of portland cements was not considered desirable at this stage of the investigation because of the complex chemical composition and reactions which take place in hydrated portland cement when it sets. It was therefore planned to produce artificially in the laboratory the chemically pure assumed constituent components of portland cement and to study individually their hydration and hydrolysis, their physical properties and characteristics, volumetric changes and related matters.

The constituent materials, and how the constituent materials of cement combine chemically under the action of heat, have been the subject of intensive experimentation and study by the best scientists from the time of Smeaton in 1756, a period of about one and three-quarter centuries.

As manufactured today, normal portland cement is made up largely of lime, silica and alumina. Chemical analyses made by us of eight different brands of well-known commercial portland cements gave the following average composition for these eight different brands:

CaO	62.96 per cent	MgO	3.42 per cent
SiO_2	21.29 per cent	Fe_2O_3	2.55 per cent
Al_2O_3	6.70 per cent	SO_3	1.77 per cent

Loss on ignition 1.28 per cent

Lime, silica and alumina constitute slightly more than 90 per cent of the cement, and the chemical combinations of these three materials are apparently of greatest importance in connection with the determination of the resulting constituent composition of commercial portland cements.

Assumed Components of Portland Cement

Naturally there have been, throughout the long range of study and experimentation briefly referred to above, many divergent theories and results, but the work has nevertheless proceeded extensively, and until fairly recently it was frequently asserted by others that commercial portland cements as at present manufactured were composed of four main constituent components, namely:

Tricalcium Silicate	$3CaO.SiO_2$
Dicalcium Silicate	$2CaO.SiO_2$
Tricalcium Aluminate	$3CaO.Al_2O_3$
Dicalcium Ferrite	$2CaO.Fe_2O_3$

and small percentages of other minor compounds more or less variable and somewhat uncertain, such as $5CaO.3Al_2O_3$, CaO, $CaCO_3$, some alkalies and added gypsum. The three compounds $3CaO.SiO_2$, $2CaO.SiO_2$, and $3CaO.Al_2O_3$ were said to make up the bulk of the cement, approximately ninety per cent of it. These results were tentatively accepted by us at the beginning of this part of the concrete investigations.

As noted in Part I of this bulletin,[1] our investigations do not establish the existence in appreciable quantities of tricalcium aluminate and dicalcium ferrite in normal portland cement.

From Bulletin No. 4, Department of Civil Engineering, Columbia University, New York.

[1]See *Cement Mill Edition* of CONCRETE, Feb., 1932, pages 51-55, and March, 1932, pages 57-62.

Molded Test Pieces

The prepared compounds of tricalcium silicate, dicalcium silicate, tricalcium aluminate and dicalcium ferrite, after mixing with water, were molded into small cylinders ½ in. in diameter and 1 in. long. Several hundred of these were made, most of them were tested in compression at the end of 7 days, 14 days, 28 days, 2 months, 4 months, and 6 months, and others were used for various studies, such as microscopic studies, volumetric changes, and studies of the action of water on chemical stability, as described later on.

The material to be mixed and molded was placed in a porcelain mixing dish and the required amount of water for the hydration of the particular compound, having been previously found by trial, was added to the dry material. This was allowed to stand for two minutes; then it was vigorously and thoroughly mixed for a period of from four to seven minutes, depending on the compound that was being mixed and to a lesser extent on the quantity of the material being mixed. The mixed material was then rapidly and carefully placed in specially made steel molds 0.500 in. in diameter and 1.00 in. high. The cylinders were removed from the molds as soon as they had hardened sufficiently to permit of their safe removal and handling. It was found that the earliest time at which the cylinders could safely be removed from the molds was, for dicalcium ferrite, 22 hours; for tricalcium aluminate, 24 hours; for tricalcium silicate, 2 days; and for dicalcium silicate, at the end of 7 days.

All test pieces were stored at room temperature in the damp closet, both before and after removal from the molds, until they were tested in compression or until they were used for other studies and tests.

SOME PHYSICAL PROPERTIES, CHARACTERISTICS AND QUALITIES OF THE COMPOUNDS

1. TRICALCIUM SILICATE

Tricalcium silicate requires a minimum of 58 per cent of its own weight of mixing water to reduce it to normal consistency. An average of 58.5 per cent was used in making the 66 cylinders in 8 different lots. The amount of mixing water required to make this component plastic, "workable," is very nearly as much as is required for tricalcium aluminate and more than double the amount required for dicalcium silicate or dicalcium ferrite.

No rise in temperature could be observed after the addition of the mixing water, such as occurred in the case of the tricalcium aluminate.

Relative Rates of Hardening

Tricalcium silicate sets and hardens less rapidly than tricalcium aluminate and a little less rapidly than dicalcium ferrite, but much more rapidly than dicalcium silicate. There is no flash set and no remixing is required, except as noted below, during placing of the mixed material in the molds.

A somewhat striking characteristic of this component is the tendency of the mass to "settle down" during mixing and placing in the molds; for soon after mixing the interior of the mass becomes dry and stiff, compact, dense, somewhat difficult to work, whereas the newly mixed material appears glossy, moist and wet-looking. This settling down is not an initial set. On remixing, the material becomes again for the moment of uniform consistency, but it again "settles down" during placing in the molds.

This characteristic was not exhibited by any of the other three compounds.

Most Valuable Component

Tricalcium silicate does not change its volume during curing and storage in the damp closet for periods of time up to 6 months. No checks or cracks were detected in the specimens under a magnification of 14X at any age up to 6 months.

Tricalcium silicate appears to be the most valuable component in portland cement. It sets and hardens fairly rapidly, does not undergo volumetric changes and remains sound under normal conditions of exposure. Its compressive strength is relatively high and continues to increase with age.

No Change in Volume

Forty test cylinders of tricalcium silicate were stored in the damp closet, maintained at about 70 deg. F. for the entire aging period, and careful measurements were made of the diameter and length of these cylinders at the ages of 7, 14, 28, 60, 90, 120 and 180 days to determine any change in volume. All of these measurements indicate that no measurable changes in volume occur in tricalcium silicate when aged in a damp closet.

Figures 1 and 2 show the condition of some of the

Figure 1. Test cylinders of tricalcium silicate at age of 4 months. No volume changes have occurred

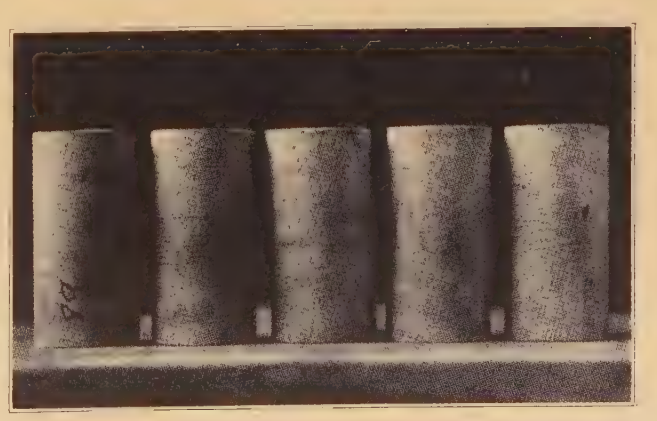


Figure 2. Test cylinders of tricalcium silicate at age of 6 months. No volume changes, checks or cracks have occurred

typical test cylinders of tricalcium silicate at the age of 4 to 6 months. No checks or cracks could be detected under a magnification of 14X in any of the cylinders cured in the damp closet for 180 days.

2. DICALCIUM SILICATE

This component requires at least 27 per cent of its own weight of gauging water to produce normal consistency. An average of 27.4 per cent was used in making the 62 cylinders in 9 different lots. This is less than half of the amount of gauging water required for tricalcium silicate and tricalcium aluminate, but is 10 per cent more than

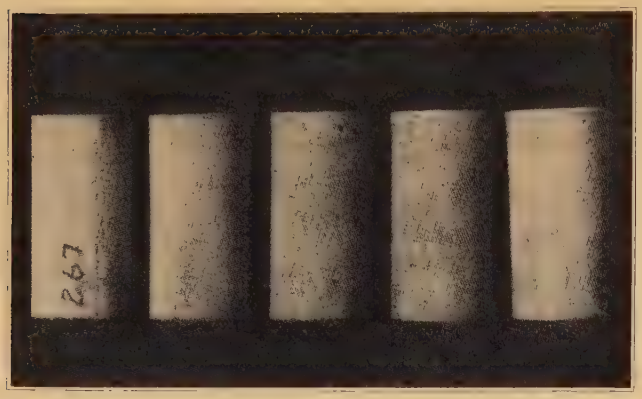


Figure 3. Cylinders of dicalcium silicate, at age of 4 months. No volume changes have occurred

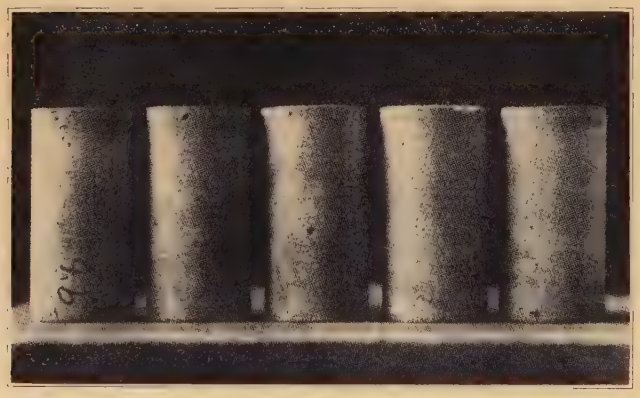


Figure 4. Cylinders of dicalcium silicate, at age of 6 months. No volume changes, checks or cracks have occurred

the amount required to produce normal consistency in dicalcium ferrite.

No rise in temperature could be observed after the addition of the gauging water. No flash set occurs and no remixing of the material is required preliminary to or during placing in the molds.

Slowest in Setting

Of the four portland cement compounds it is the slowest in setting and hardening. Twenty-four hours after molding a slight touch from the finger nail produces a deep indentation. At 7 days a slight impression can still be made. The rate of setting is so slow that the test cylinders could not be removed safely from the molds until 7 days after molding, and even then considerable care was required to guard against breakage. Cylinders of this component did not set as hard at the age of 7 days as those of tricalcium silicate at the age of 2 days.

The setting, hardening, and increase in strength of dicalcium silicate is very gradual and continuous for a long period of time. The compressive strength is exceedingly low at early ages, but increases consistently after the age of 4 months.

At the age of 7 days the cylindrical surfaces of the test specimens feel somewhat powdery and chalky, and small quantities of white powdery material adhere to the fingers, though not freely like chalk. At the age of 2 months the hardening has proceeded to the extent that the cylinders begin to give off a stony sound when scratched with a knife. The gradual increase in compressive strength with age, of portland cement mortar and concrete, after the age of four months appears to be largely due to this component.

Dicalcium silicate is more granular ("sandy") in texture than any other of the four compounds studied. The molded surfaces of the cylinders are not as smooth and glassy as those of tricalcium silicate.

For ages up to 6 months no volumetric changes occurred in dicalcium silicate when cured in the damp closet and no checks or cracks could be detected under a magnification of 14X in any of the specimens.

For these reasons this compound appears to be a valuable one in portland cement even though it possesses the characteristics of slow setting, low early compressive strength and slow increase in compressive strength with age.

No Volume Changes Occur

On 41 cylinders of dicalcium silicate measurements were taken on both the diameter and length at ages of 14, 21, 28, 60, 90, 120 and 180 days, but no change in dimensions could be detected. During this entire period all cylinders were stored in a damp closet at about 70 deg. F.

Figures 3 and 4 are taken from photographs of some of the cylinders of dicalcium silicate taken just before they were tested in compression. All cylinders of dicalcium silicate, when cured in the damp closet or immersed in water, remained sound. No warping, checks or cracks could be detected in any of these cylinders.

(To be continued)

Chemical Society Leases Quarters in Chicago Building

Establishment of a chemical center in Chicago is expected to follow the recent leasing of facilities in the Midland Building by the Chicago section of the American Chemical Society. Members of the section are thus given the use of the Midland Club quarters for meetings.

At the same time members of the Chicago Chemists Club took over club quarters on one floor of the building.

Texas State Cement Ordered Shipped in Cotton Bags

Shipment in cotton bags of all cement sold to the state of Texas is mandatory as the result of order issued in February by the State Board of Control.

Economy of Electric Operation for Quarry Loading and Haulage

Cost Figures Show Trinity's Electric System at Fort Worth Has Marked Advantage Over Steam Shovels and Locomotives at Dallas

THREE recent issues of the *Cement Mill Edition* of CONCRETE (November, December and January) contain detailed descriptions of operating methods and costs in the quarrying and crushing operations at the Dallas plant of the Trinity Portland Cement Co., Dallas, Tex. The three articles just mentioned are taken from Information Circular No. 6498, issued by the U. S. Bureau of Mines.

The February (1932) issue, pages 63 to 65, contains an abstract of Information Circular No. 6513, also issued by the U. S. Bureau of Mines, in which the operating methods described and the cost data given pertain to the same company's quarry at Fort Worth, Tex., a close neighbor of Dallas. Both information circulars were prepared by J. William Ganser, chief chemist of the Trinity Portland Cement Co. and one of the consulting engineers of the U. S. Bureau of Mines.

Comparison of Loading and Haulage Costs

Aside from the fact that both information circulars (Nos. 6498 and 6513) are the production of the same author, the cost data in each case cover the same period—the full year 1929. During that time the production of stone at the two quarries was almost identical, the output of the Dallas quarry having totalled 295,768 tons, including the overburden, while the Fort Worth quarry's output was 294,883 tons, also including the overburden. While the rock deposits are different in a geological sense, limestone and shale are quarried in both cases.

The loading and hauling operations, however, are carried on under wholly different methods and types of equipment. In consequence, a direct comparison of loading and hauling costs may be extracted from the data supplied in the two cases.

The cost tabulations to be given here—and the same is true with the articles previously published—represent local operating expenditures only, not total production costs.

The loading and hauling operations at the two quarries have been described in previous issues—those at the Dallas quarry in the December issue, pages 58 and 59, and those at the Fort Worth quarry in the February issue, page 63. The essential features of these operations will be repeated here for convenience.

Steam Operation at Dallas Quarry

At the Dallas quarry the limestone is loaded by a caterpillar steam shovel with a dipper capacity of 2½ cu. yd. The shale is loaded by an older 2-yd. steam shovel of the railroad type, which operates on tracks.

The limestone and shale are hauled to the crushing plant by two 35-ton standard gauge steam locomotives, one of which has been in operation since 1909 and the other since 1917. Each locomotive pulls eight 6-yd. side-dump cars, representing a total load of 65 tons of rock. Trains are limited to eight cars because of the existence of grades as high as 5 per cent in the track layout.

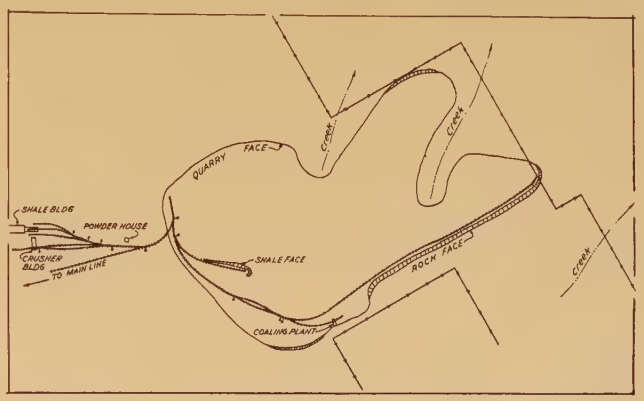


Figure 1. Quarry and track layout at Dallas

In the hauling of shale, trains are limited to four cars because the shale storage capacity accommodates only four carloads at a time.

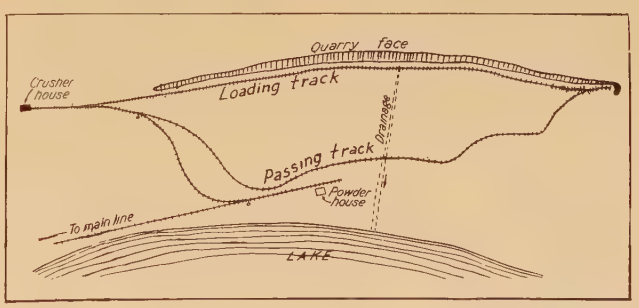


Figure 2. Quarry and track layout at Fort Worth

The locomotives and the shovels use coal as fuel, which is drawn from the bottom of the coal hoppers.

Electric Operation at Fort Worth

At the Fort Worth quarry, located about 5 miles north of the city, electric operation is employed both in loading and hauling. The haulage system is operated by remote control from a central control tower located at the crushing plant.

All the stone is loaded by a No. 50 Bucyrus electric shovel with caterpillar tractors. A 100-hp., 2,200-volt

motor drives a generator which delivers a 230-volt current to a 60-hp. motor on the hoist of the dipper, a 13-hp. motor which swings the shovel, and a 13-hp. motor on the thrust. A 5-hp. motor on the dipper trip, a 2-hp. motor on the air compressor and 7½-hp. motor on the exciter are run by 440-volt current received through a transformer from the 2,200-volt leads. This system of motors is called the Ward-Leonard control. It is necessary to have only one man on the shovel and one man in the pit, who removes large rocks that might fall on the track and also signals with a flag to the tower man as to where to stop the electric car and when to move it after it is loaded.

Inasmuch as the electric transportation from the quarry to the crusher was described in detail on pages 63 and 64 of the February issue, only a few of the essential features will be given here. The cars, for instance, are 10-yd. one-way side-dump cars. Each car has two 30-hp. Allis-Chalmers motors. Three of these cars are in operation, and each is equivalent in power to a 35-ton locomotive.

This system, which is known as the Woodford electric haulage system, employs a third rail using a 250-volt direct current. Each controller provides for three running speeds, one off position for coasting, and three brake positions for various brake pressures. When the controller handle is in the off position a car will coast until the brake current is turned on. The controls are set so the operator need not attend to the cars except for a few feet at the loading and discharge ends, where they require accurate spotting. Operation of the system is simple, since everything is in full view of the tower operator from the time the cars leave the crusher building until they are loaded and returned to it.

Marked Difference in Quantity of Labor

From the fact that the production was almost identical in the two quarries in 1929, it is of interest to note the great difference in the number of workmen in the quarries, and the consequent difference in labor man-hours per ton of stone produced.

In the Dallas quarry the normal working force consists of a foreman, 14 skilled workman and 15 common laborers, making a total of 30 men. The Fort Worth quarry force consists normally of 5 skilled workmen, a pit man, a driller's helper and a crusher-tender helper, making a total force of 8 men. The absence of a quarry foreman at Fort Worth is explained from the fact that he would have little to do. The mill foreman attends to what little supervision is necessary.

Labor Man-Hours Per 100 Tons

The reduced working force in the Fort Worth quarry is, quite naturally, reflected in a greatly reduced number of man-hours of labor per 100 tons of stone produced. The difference in the results attained at the two quarries in this respect is shown in Table 1.

TABLE 1

Man-Hours of Labor Per 100 Tons of Stone Produced

	Dallas Quarry	*Fort Worth Quarry*
Loading	8.40	3.30
Haulage	20.90	5.34
Totals	29.30	8.64

Labor Costs Per Ton

The labor operating costs at the two quarries, per dry ton of stone produced, are given in Table 2. The cost at Dallas includes $0.0051 per ton for supervision.

TABLE 2

Labor Operating Costs Per Dry Ton of Stone Produced

	Dallas Quarry	*Fort Worth Quarry*
Loading	$0.0523	$0.0203
Haulage	.0902	.0306
Totals	$0.1425	$0.0509

Total Loading and Haulage Costs

The total operating loading and haulage costs at the two quarries, per ton of stone produced, are given in Table 3. From these figures it appears that in other directions, aside from labor, the electric loading and haulage system employed at the Fort Worth quarry has the advantage over the system employed at Dallas, although a part of the difference may be ascribed to the fact that the Fort Worth installation is considerably newer than the one at Dallas. As matters stand, however, the total operating loading and haulage costs are $0.2320 per ton of stone produced at Dallas, compared with $0.0746 at Fort Worth. If these figures are translated into barrels of cement, the difference amounts to 4.7 cents per bbl. if we assume that 600 lb. of stone are required for the production of one barrel of cement.

TABLE 3

Total Loading and Haulage Costs Per Ton

	Loading		*Haulage*	
	Dallas	*Ft. Worth*	*Dallas*	*Ft. Worth*
Labor	$0.0523	$0.0203	$0.0902	$0.0306
Power	.....	.0015	.....	.0028
Fuel	.0357	.....	.0244	.....
Supplies	.0159	.0075	.0135	.0119
Totals	$0.1039	$0.0293	$0.1281	$0.0453

Shovels and locomotives at the Dallas quarry consumed 18 lb. of coal per ton of stone produced.

Average cost of electric power at Ft. Worth quarry is 8 mills per kwh.

Two Safety Council Conferences in April

Two conferences are scheduled to be held by the National Safety Council early in April. The first is the tenth annual midwest safety congress in Chicago on April 6 and 7. The ninth annual safety engineering conference will be held on April 7 in Pittsburgh.

Power Formulas for Chain Conveyors and Elevators

Example Illustrates Use of Formulas—Applies to Elevators and Horizontal and Inclined Conveyors

By MARTIN H. KIDDER
Link-Belt Company, Chicago, Ill.

In the following instructions and calculations for figuring the pull on chains in conveyors and elevators, and in drives for them, as well as the torsional and bending strains for the shafting, the letters and characters used in the formulas have the definitions listed below:

α = Angle of inclination of conveyor or elevator.

B = Bending moment for head shafts in inch-pounds.

C = Additional pull to drag buckets through elevator boot.

D = Diameter of chain roller.

d = Diameter of chain pin.

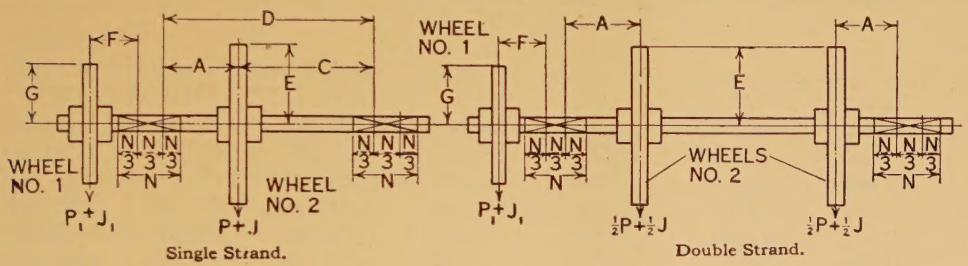
F = Coefficient of sliding friction between chain or wearing shoe and track. See table which follows, for values.

F_1 = Coefficient of sliding friction between material conveyed, such as coal, sand, etc., and the conveyor trough. See table.

RF = Coefficient of rolling friction. See table.

J = Weight of moving parts of conveyor or elevator, such as chains, wheels, buckets, flights, etc., which are supported by the head shaft. See wheels 2 of illustration.

J_1 = Weight of driving wheel, gear or pulley on head shaft, with such of the chain or belt as is supported by this "wheel 1," of illustration.



Single Strand. Double Strand.

L = Length of conveyor or elevator from head shaft to foot shaft, in feet.

P = Load or resistance to turning, measured in pounds, at the pitch radius of head sprocket or sprockets, which must be balanced by pull of driving mechanism.

P_1 = The equivalent pull necessary at pitch radius of the driving wheel, gear or pulley, on this head shaft.

T = Torsional moment for head shafts in inch-pounds.

W = Weight of chain and flights, pans, or buckets, per foot.

W_1 = Weight of material, such as coal, sand, etc., per foot of conveyor or elevator.

Turning Efforts

Vertical Elevators

(a) $P = (W_1 \times L) + C$

Horizontal Scraper Conveyors

With chains and material sliding

(b) $P = (2 \times W \times L \times F) + (W_1 \times L \times F_1)$

Horizontal Scraper Conveyors

With roller chains supporting flights, and material sliding

(c) $P = (2 \times W \times L \times RF) + (W_1 \times L \times F_1)$

Horizontal Conveyors

Which carry the material

(d) $P = (2 \times W + W_1)\ (L \times RF)$

Inclined Scraper Conveyors

With chains and material sliding

(bb) $P = (W \times L)\ (F \times Cos\ \alpha + Sin\ \alpha) + (W_1 \times L)\ (F_1 \times Cos\ \alpha + Sin\ \alpha) + (W \times L)\ (F \times Cos\ \alpha - Sin\ \alpha)$

Inclined Scraper Conveyors

With roller chains supporting flights, and material sliding

(cc) $P = (W \times L)\ (RF \times Cos\ \alpha + Sin\ \alpha) + (W_1 \times L)\ (F_1 \times Cos\ \alpha + Sin\ \alpha) + (W \times L)\ (RF \times Cos\ \alpha - Sin\ \alpha)$

Inclined Conveyors

Which carry the material

(dd) $P = L\ (W + W_1)\ (RF \times Cos\ \alpha + Sin\ \alpha) + (W \times L)\ (RF \times Cos\ \alpha - Sin\ \alpha)$

Coefficients of Friction F, F_1 and RF

Sliding Friction

F = .33 for metal on metal.
F_1 = .59 for Bituminous coal on metal.
= .33 for Anthracite coal on metal.
= .355 for coke on metal.
= .53 for moist ashes on metal.
= .60 for dry sand on metal.
= .585 for limestone on metal.
= .325 for shelled corn on metal.

Rolling Friction

$$RF = X \times \frac{d}{D}$$

When X = .5 for iron pin in cored roller, not oiled.
= .33 for iron pin in cored roller, greased.
= .25 for steel pin in bored roller, greased.
= .20 for steel pin in bored roller, well oiled.

Illustrative Example

The equations for horizontal conveyors are simple, and need no further explanation. The following example illustrates the procedure to determine turning effort or pull, for an inclined apron conveyor.

Example—Determine the turning effort for an apron conveyor 164′ 0″ centers, having an inclination of 23°. The weight of the carrier empty is 92 lb. per ft., and the weight of material handled is 200 lb. per ft. The chains have 6-in. diameter enclosed-oiling rollers, turning on 1½-in. bushings. Then L = 164, α = 23°, Sin 23° = 0.39, Cos 23° = 0.92, W = 92, W_1 = 200.

$$RF = 0.20 \times \frac{1.5}{6} = 0.05.$$

The turning effort necessary to operate the conveyor, figured from the equation given for roller chain conveyor which carries the material (formula "dd"), is

$P = 164\ (92 + 200)\ (0.05 \times 0.92 + 0.39) + (92 \times 164)\ (0.05 \times 0.92 - 0.39)$.

$P = 47888 \times 0.436 - 15088 \times 0.344$.

$P = 20879 - 5190 = 15{,}689$ = The torsional effort or pull acting at the radius of the sprocket wheels.

Horse Power

To the turning effort just given, 10 per cent should be added for the friction of the head and foot shafts, and 15 per cent for each pair of gear reductions, for the gross turning effort. Provision should also be made for excessive starting loads.

The necessary horse power can be computed from the equation:

$$\text{Horse Power} = \frac{\text{Gross turning effort} \times \text{speed in ft. per min.}}{33{,}000}$$

Chain Stresses

In the case of vertical elevators with single chain, the stress in chain equals the turning effort P plus the weight of one run. For double strand chains the stress in each chain equals one-half of this.

In the case of horizontal conveyors the chain stress equals the turning effort or pull only, in a single strand conveyor; and one-half this amount for each chain in a double strand conveyor.

For inclined conveyors the chain stress at head equals the pull due to weight of the carrying run, plus the pull due to weight of material on the conveyor, provided the incline of the conveyor is sufficient to cause the return run to move down the incline by gravity. If the incline is insufficient, and the foot wheels have to pull the return run of conveyor down the incline, this pull must be added to the above forces.

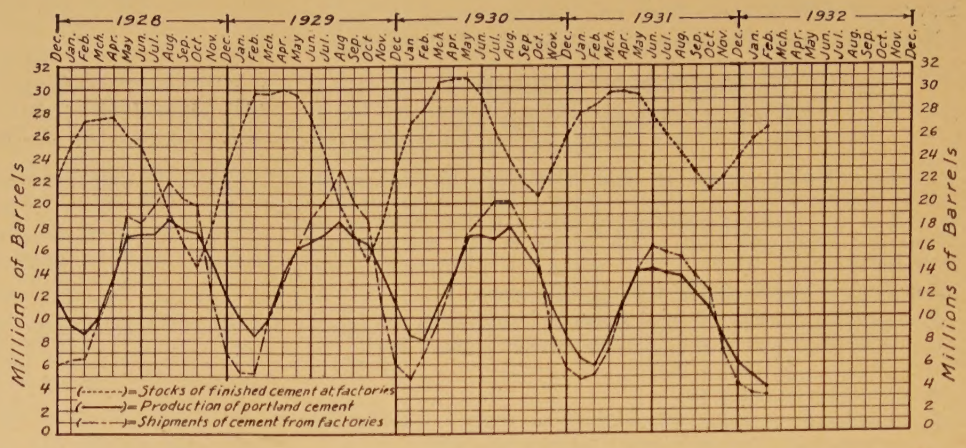
In the case of the example given, the total chain stress at the head equals 20,879 lb., while the torsional pull amounts to 15,689 lb.

Cement Statistics for February

Increases in Production Seen in Central and Two Eastern States

Relation of Production to Capacity

	The Month, Per Cent	The Twelve Months, Per Cent
February, 1932	18.7	45.2
February, 1931	29.4	59.7
January, 1932	22.0	45.9
December, 1931	26.4	46.5
November, 1931	37.2	44.4



	1931	1932	Increase or Decrease, %
Production, February	5,920,000	3,971,000	—32.9
Production, February	5,074,000	3,118,000	—38.5
Stocks at end of month	28,612,000	26,631,000	—6.9
Total production for yr.	12,515,000	8,997,000	—39.1
Total shipments for yr.	9,766,000	6,511,000	—49.9
No. of plants reporting	165	165	0

Production, Shipments, and Stocks of Finished Portland Cement, by Districts, in February, 1931 and 1932, and Stocks in January, 1932 (In Barrels)

District	Production—February 1931	Production—February 1932	Shipments—February 1931	Shipments—February 1932	Stocks at end of month 1931	Stocks at end of month 1932	Stocks at end of January, 1932*
Eastern Pa., N. J., and Md.	1,630,000	1,315,000	1,123,000	851,000	6,054,000	5,706,000	5,242,000
New York and Maine	151,000	319,000	182,000	166,000	1,957,000	1,575,000	1,423,000
Ohio, Western Pa., and W. Va.	412,000	215,000	415,000	284,000	3,705,000	3,405,000	3,474,000
Michigan	109,000	114,000	219,000	121,000	2,814,000	2,093,000	2,099,000
Wis., Ill., Ind., and Ky.	427,000	515,000	416,000	249,000	3,966,000	3,386,000	3,120,000
Va., Tenn., Ala., Ga., Fla., and La.	836,000	290,000	768,000	359,000	1,833,000	1,749,000	1,817,000
Eastern Mo., Ia., Minn. and S. Dak.	766,000	358,000	377,000	150,000	3,458,000	3,698,000	3,491,000
W. Mo., Nebr., Kans., Okla., and Ark.	263,000	179,000	404,000	239,000	2,077,000	1,942,000	2,003,000
Texas	286,000	280,000	328,000	256,000	740,000	847,000	823,000
Colo., Mont., Utah, Wyo., and Idaho	160,000	7,000	82,000	38,000	486,000	456,000	486,000
California	709,000	316,000	602,000	343,000	938,000	1,124,000	1,151,000
Oregon and Washington	171,000	63,000	158,000	62,000	584,000	650,000	649,000
	5,920,000	3,971,000	5,074,000	3,118,000	28,612,000	26,631,000	25,778,000

Production, Shipments, and Stocks of Finished Portland Cement, by Months, in 1931 and 1932 (In Barrels)

Month	—Production— 1931	—Production— 1932	—Shipments— 1931	—Shipments— 1932	Stocks at end of month 1931	Stocks at end of month 1932
January	6,595,000	*5,026,000	4,692,000	*3,393,000	27,759,000	*25,778,000
February	5,920,000	3,971,000	5,074,000	3,118,000	28,612,000	26,631,000
March	8,245,000	.....	7,192,000	.....	29,676,000	.....
April	11,245,000	.....	11,184,000	.....	29,715,000	.....
May	14,010,000	.....	14,200,000	.....	29,554,000	.....
June	14,118,000	.....	16,077,000	.....	27,602,000	.....
July	13,899,000	.....	15,545,000	.....	25,934,000	.....
August	13,549,000	.....	15,172,000	.....	24,313,000	.....
September	12,092,000	.....	13,671,000	.....	22,736,000	.....
October	10,762,000	.....	12,360,000	.....	21,218,000	.....
November	8,161,000	.....	7,156,000	.....	22,219,000	.....
December	5,974,000	.....	4,142,000	.....	*24,098,000	.....
	124,570,000	.....	126,465,000	.....	.....	.....

*Revised.

Blacker type indicates larger of two figures.

MEN and MILLS

[News of and for Cement Mill Men]

A clearing-house page for all kinds of local cement mill news—to promote the comradeship and mutuality of interest that exists among those who make portland cement.

Readers in all mills, even though not regular contributors, are invited to send in news notes about personal and plant activities that may be of interest or value to the men in other mills.

Thirteen Universal Atlas Plants Leap February 29 Without Accident

"Although Leap Year caused February to have an extra day, this fact did not spoil the perfect record of no lost-time accidents by the thousands of workers in all thirteen mills of the Universal Atlas Cement Company," announced B. F. Affleck, president of the company.

"Even more noteworthy," he said, "is the fact that three plants have each come through their fourteenth consecutive month without a single lost-time accident." These plants are located at Northampton, Pa.; Leeds, Ala., and Independence, Kans.

"Three things are responsible for the achievement of these records," said Gordon C. Huth, safety director of the Universal Atlas Company. "First, modern safety equipment is installed wherever needed to protect workers. Second, thorough responsibility is assumed by operating officials and supervisory forces. And finally, intelligent co-operation is given by every member of the organization."

Cement Company Head Kidnaped and Robbed

Robert B. Dickinson, 51, vice-president and general manager of the Marquette Cement Manufacturing Co., at Chicago, was kidnaped early on the morning of March 5 by two men, who robbed and threw him from their auto after driving three miles.

Dickinson and E. P. Rich, a consulting engineer, were emerging from the Swedish Club in North La Salle Street when the bandits seized them and forced them into a taxicab. Rich fought himself free and the robbers drove away with Dickinson.

Rich reported the case to the detective bureau. For a time it was feared Dickinson had been kidnaped for other motives than robbery. He later reported himself free, however.

Lone Star Workers Given $1,000 for Safety Records

Checks totaling $1,000 for no-accident operation were distributed among employees of the Lone Star Cement Co. (Kansas), at the regular safety meeting held early in February.

This was divided into regular safety bonus money of $800 and a special cup award of $200.

In 1926 the International Corp., in order to develop interest in safety work, inaugurated in each of its subsidiaries a plan of providing annually a safety trophy cup which is open to annual competition, and is each year awarded to the department which has the longest continuous no-lost-time accident record.

For the purpose of carrying out the idea of competition the plant employees were divided into twelve groups or departments. If a member of any one of these groups suffers a lost-time accident, the group or department immediately is dropped out of the competition.

In addition, the management provides cash awards to be paid to all employees who may be engaged in any department as listed in connection with the safety trophy cup and which department as a unit completed one or more consecutive years without a lost-time accident. These awards range from five to thirty dollars for each individual in the group.

Florida Portland Officers Are Re-elected

All officers of the Florida Portland Cement Co. were re-elected at the annual meeting of directors held at Tampa on February 18.

On the day following the business meeting, local and visiting plant officials went on a deep sea fishing trip from Tarpon Springs.

Those attending the meeting included John L. Senior of Chicago, president; S. W. Storey, Chicago, vice-president; H. L. Miller, Chicago, secretary; W. A. Sadd and L. H. Caldwell, Chattanooga, and John W. Esmond and Fritz Worm, Chicago, directors.

H. S. Wright Appointed Boston Representative of Forms Manufacturer

Harry S. Wright, formerly assistant manager of the structural bureau of the Portland Cement Association and more recently with Stevens Master Specifications, Inc., Chicago, has been appointed Boston representative of the Metal Forms Corporation, of Milwaukee, Wis.

J. B. John Given Honor Certificate by Holmes Safety Association

J. B. John was among those given a certificate of honor by the Joseph A. Holmes Safety Association at its annual meeting held in Washington, D. C., recently. The presentations were made in recognition of operation over long periods of time without fatalities or lost-time accidents.

Mr. John is president and general manager of the Medusa company, general manager of the Petoskey company, and chairman of the safety committee of the Portland Cement Association. In 1930, eight of the nine plants under his direction won the Portland Cement Association trophy for operating a full year without a lost-time accident. Every plant under his management has won the association trophy one or more years.

Wright Flies Plane Up 18,500 Feet

H. B. Wright, research engineer for the Portland Cement Association at Chicago, who keeps his plane, a Commandair powered with a Wright 160-horsepower engine, at Curtiss Airport near Glenview, decided one day recently to find out how cold it was up in the air. He flew his plane to a height of 18,500 feet above the airport and found the temperature to be fifteen degrees below zero. That was about thirty-five degrees colder than the temperature on the ground.—*Wilmette Life.*

Utah-Idaho Reorganization Group Discusses Rebuilding of Burned Plant

Rehabilitation of the burned plant of the Utah-Idaho Cement Co., at Bakers, Utah, was discussed at a meeting of members of the reorganization committee at Ogden, Utah, on March 10.

Members of the committee are W. H. Harris, chairman; Richard F. Beck, Salt Lake City; Albert E. Becker, Albert Whitmeyer, R. S. Jones, and C. B. Empey.

Louisville Cement Replaces Wagons With Truck

The Louisville Cement Co. has disposed of its teams and purchased a truck.

Mill Equipment

New Electric Unit Heater on Market

The Soverhill Electric Grid Heater, a unit type heater, has been placed on the market by the Soverhill Engineering Co., Chicago, Ill.

These heaters are said to be complete, self-contained heating plants, especially suited for the heating of isolated places, offices, or any space where low installation cost, automatic control and quick heating are desired. When thermostatically controlled, it is said, they have proved ideal for maintaining uniform control in laboratories.

The heating element used in all types and models is a specially formed helicoil sheath wire unit made by the General Electric Co. This element, the manufacturer claims, is practically indestructible, and is unaffected by vibration or severe operating conditions.

New Heavy-Duty Vibrating Screens Announced by Link-Belt

Two new types of vibrating screens have just been announced by Link-Belt Company, Philadelphia, Pennsylvania. These screens are known as:

(1) Link-Belt positive-drive-type, heavy-duty vibrating screen, which is made with both single and multiple decks.

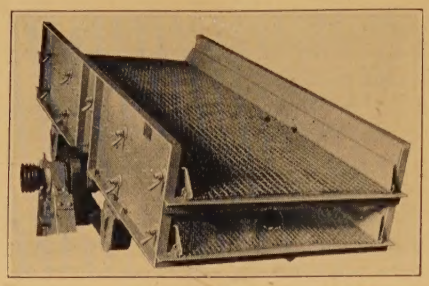
(2) Link-Belt unbalanced-pulley-type, heavy-duty vibrating screen, made with single and multiple decks.

These two additions to the Link-Belt line of vibrating screens fill industry's needs where large screen openings are required and heavy capacities must be handled.

The positive-drive-type is shown in Fig. 1, in the single-deck design, the feed end being in the foreground. This type screen can be furnished to provide any given fixed amplitude, with shaft speeds to suit.

In the positive-drive-type screen, the amplitude of vibration is fixed at the factory, before shipment, to suit the work the screen is to do. Any given amplitude will cover a wide range of screening surface openings. The angle of the screen inclination, the speed of operation and the direction of the rotation, all are readily changed at any time to suit the kind, size and condition of material to be screened. The rotation determines whether the vibrations are with or against the flow of the material.

The double deck screen illustrates the accessibility of the screen cloths, and that they are placed under tension crosswise by



side tension members which also serve as wearing plates and prevent material from leaking along the edges. Only the screen cloths need to be removed when replacements are required.

Cantilever leaf springs serve to maintain the screen box at a constant angle, being adapted for the circular motion produced by the action of the eccentric-driven positive drive. Oversize self-aligning spherical roller bearings are used. A steel subframe is regularly furnished as a part of the screen, and it can be supported from below, or hung by cables from above.

The unbalanced-pulley-type, heavy-duty screen is available with single or multiple decks, for high speed work where the material is of a sticky nature, and on close-sizing problems where the screen openings are not large.

About the Manufacturers

Industrial Literature

Briggs Tip Hammer Bulletin

A new descriptive bulletin on the Briggs renewable tip hammer for hammer mills has been issued by *William C. Briggs*, Philadelphia, Pa.

Attention is called to the savings made available by its use, and the promise of even greater ones through the increased reduction in the product, using the same amount of power.

The principle of the hammer, results secured, and sizes and details are given.

Diamond Belt Conveyors

Presented in a large way, the contents of a new booklet on the handling of raw materials by belt conveyor are striking.

The publication, prepared by the *Diamond Rubber Co.*, Akron, Ohio, is entitled "How Shall We Handle It?"

Illustrations cover different types of installations, including those in four cement mills.

The Traylorian

Bits of lighter reading are sandwiched in between equipment descriptions and the portrait and character sketch of *President W. J. Roberts* in the January-February issue of the *Traylorian*.

This bi-monthly is issued by the *Traylor Engineering and Manufacturing Co.*, Allentown, Pa.

Electromet Bulletin

Chrome-vanadium nitriding steel is the subject of the January, 1932, issue of the *Electromet Technical Bulletin*, issued by the *Electro Metallurgical Co.*, New York City. The latter is a unit of the *Union Carbide and Carbon Corporation*.

The publication's purpose is to acquaint metallurgists and engineers with the physical properties and advantages of nitriding steel containing substantial amounts of chromium and vanadium.

This steel, developed at the Union Carbide and Carbon Research Laboratories, Inc., is said to be rugged and dependable and easily manufactured to meet a wide range of specifications. More complete details on the uses and properties of the steel than are contained in the bulletin may be had upon request.

Notes from the Field

Belt Patent Suit Settled

The Allis-Chalmers Mfg. Co. announces that the suit between it and the *Dayton Rubber Mfg. Co.*, of Dayton, Ohio, in United States District Court at Cincinnati, Ohio, involving patent infringement of Allis-Chalmers Geist patent, No. 1,662,511, pertaining to Multiple "V" belt drives, has been settled out of court. The Dayton Co. takes a license under the Geist patent and the Allis-Chalmers Co. has the right to operate under Short patent, No. 1,538,303, if it so desires.